Motivation Letter For The Master of Artificial Intelligence

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Abstract

The here presented experiment documents an effort to qualify for the Master of Artificial Intelligence at the Institute of Data Science in Maastricht. In order to demonstrate fascination for the field I created an artificial neural network that can represent my interdisciplinary background in psychology and data science. A genetic algorithm was used to evolve the network's hyper-parameters. The results are promising and will be discussed in the light of my passion for intelligent systems. Implications of this qualification for the master program are discussed. An outlook towards a career in computational neuroscience concludes the motivation letter.

The future belongs to those who believe in the beauty of their dreams - Eleanor Roosevelt.

Introduction

My dream is to become a computational neuroscientist unravelling the mysteries of the human brain. As this field merges neuro- and data science I am on the mission to obtain an interdisciplinary education. I believe the master in artificial intelligence to be an important piece of the puzzle.

My fascination for the brain was sparked during a Bachelor in Psychology. I was fascinated to learn about information processing architectures of perception, cognition and motor control. A master in neuroscience appeared to be the natural continuation of this journey. These programs teach how to use a functional magnetic resonance scanner or a near infrared spectroscope to conduct research in the field. Yet their offer on signal processing, computational statistics or mathematical modeling is limited to at most 13 ECTS credits [1]. An education in data science might not offer courses on measuring brain signals but it does offer courses on data analysis.

I decided to prioritize data science and enter the Faculty of Science and Engineering for a second Bachelor's degree. In this new habitat I was enlightened by courses on mathematics including Linear Algebra, Probability and Statistics and Mathematical Modeling. Various computer science courses taught me to think algorithmically. My understanding of information processing mechanisms in the human brain was put in perspective when I followed courses on machine learning and natural language processing.

I am convinced that the study of the human brain inspires the field of data science and vice versa. My interdisciplinary qualification allows me to leverage knowledge from both fields to synthesize new insights. This ability will be demonstrated by the following artificial neural network whose hyper-parameters were calibrated by simulated evolution. The network is capable of representing a network of relevant courses I followed at University.

Methods

The data for this experiment was obtained by collecting 28 courses along with their conceptual relations in a graph. The neural network's architecture comprised input and output layers with 28 neurons each, and an encapsulated hidden layer. The input and hidden layers were extended by a bias neuron and the hidden and output layers implemented the sigmoid activation function for neurological plausibility. During calibration each course was entered to the network as a distinct unit vector of the standard 28-dimensional basis. The network was then supervised to predict a binary vector equal to the sum of vectors from conceptually related courses. For simplicity, the squared error averaged across all input courses was used as objective function. Future implementations might benefit from activating the network's output by means of a normalized exponential and using a cross entropy loss to make the output statistically easier to interpret.

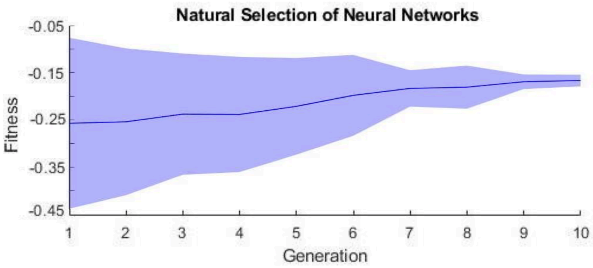
In order to select the most effective hyper-parameters for the neural network a genetic algorithm was developed. The hyper-parameters were synaptic strength at network initialization, the number of neurons in the hidden layer as well as the learning rate. For each of them a chromosome was reserved whose alleles coded different options, e.g. a uniform or normal random distribution for initial synaptic strength. Despite an original set of 2-4 alleles per chromosome a mutation rate of 30 percent was used to introduce further genetic diversity for each generation. Based on its genotype an individual neural network was instantiated and calibrated for 2000 epochs using gradient descent. The average negative loss across this time span was used as a measure of its fitness.

A population of 32 individuals was generated and partitioned into quartets. The least fit individual of each quartet was filtered out. Two of the remaining individuals were allowed to reproduce sexually while the third one reproduced asexually. Throughout the simulation a total of 10 generations with the same population size were created. From the final cohort a representative was selected and received an additional

2000 epochs of training to demonstrate its knowledge about the course graph.
The simulation was written entirely by myself in Matlab without the use of any toolboxes and it is accessible via the repository https://github.com/TimHenry1995/Application. The curious reader is recommended to download the project and run the main script to verify the here presented results. Additional visualizations are provided as well.

Results

The first figure shows the natural selection process of the neural networks. In dark blue the average fitness of the population is shown while in light blue 1.96 times the standard deviation of fitness is shown. One can see that the population's fitness increased over generations while the variability decreased. It appears that the species successfully adapted to its ecological niche.

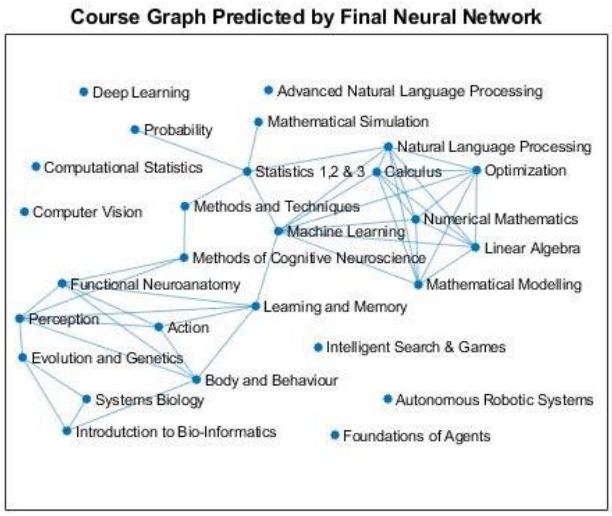


The second figure shows the course graph predicted by the representative individual of the final generation. One can recognize a cluster for data science related courses next to cluster for neuro-scientific courses. The predicted graph corresponds to the expected one for 99 percent of course relations. Observe that the unconnected nodes correspond to courses from the Master of Data Science and Artificial Intelligence that I would like to participate in. To facilitate the network's understanding of these courses further supervision is required.

Discussion

The here presented experiment documents an effort to let an artificial intelligence participate in authoring a motivation letter. Inspired by nature, a species of artificial neural networks was evolved to generate a graph of course relations. The experiment shows how natural optimization mechanisms can inspire the development of algorithms implemented *in silico*. From a mathematical point of view artificial neural networks are compositions of functions whose parameters are optimized through algorithmic procedures such as the method of conjugated gradients [2]. But their architectures often include elements reminiscent of natural neural networks. For instance, receptive fields for perception, recurrent connections for memory and attention mechanisms for information retrieval [3].

The implications of my admission to the Master of Data Science and Artificial Intelligence are far reaching. On the one hand I would able to supervise the here presented graph network to extend its



knowledge to master courses. Deep Learning, Advanced Natural Language Processing or Applications of Computer Vision are courses that would allow me to deepen my understanding intelligent systems. Courses such as Signal and Image Processing, Algorithms for Big Data and Mathematical Optimization would provide me with a strong analytical component [4]. On the other hand admission to this master would enable me to work with renowned researchers such as Dr. Rico Möckel from the Institute of Data Science on brain computer interfaces. Apart from lending itself to a fascinating topic for a master thesis such a project can also help me to qualify for a Ph.D. in computational neuroscience.

Conclusion

In a nutshell, my motivation for the Master of Artificial Intelligence stems from an interdisciplinary background. Admission to the program would equip me with the mathematical, algorithmic and data scientific methods needed to shape my understanding of intelligent systems for the long run.

References

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